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XX. *A Description of the Teeth of the Anarrhichas Lupus Linnæi, and of those of the Chætodon nigricans of the same Author; to which is added, an Attempt to prove that the Teeth of cartilaginous Fishes are perpetually renewed. By Mr. William Andre, Surgeon; communicated by Sir Joseph Banks, Bart. P. R. S.*

Read March 18, 1784.

THE amazing variety there is in the external form of fishes must be obvious to a common observer; and whoever examines will be convinced, that the same variety prevails in their internal structure. No parts, perhaps, afford a more convincing proof of the last assertion than the teeth of fishes. To adduce a few instances, let us only recollect the tuberculated teeth in the thorn-back; the triangular serrated teeth in the shark; the slender flexible teeth in the *chætodontes*, or angel-fishes. There is not only a difference of their form, but also in the substances of which they are composed; some being of a soft horny nature; others made up of bone; others of that substance we call enamel in the teeth of quadrupeds; and some having the apparent hardness and transparency of crystal. We may also notice their uncommon situation; many fishes having teeth not only in their jaws, but on the tongue, the palate, and about the *fauces*.

To illustrate in some degree this part of natural history, I shall describe the teeth of the *Anarrhichas Lupus*, or Sea-wolf, and those of the *Chætodon nigricans*, a species of Angel-

Angel-fish. The former have been but imperfectly described, and never represented distinct from the fish, without which it is impossible to have any exact idea of their disposition, number, or form, while the true shape and composition of the latter, from their minuteness, have been entirely overlooked. I shall then attempt to prove, that a continual renovation of the teeth takes place in cartilaginous fishes.

THE SEA-WOLF is a fierce and ravenous fish, as its name imports, found in the northern parts of the globe, where it frequently grows to the length of four feet and upwards.

The jaws of the Wolf-fish are made up of several bones, to each of which a greater or less number of teeth are affixed; but, before I enter upon the description of them, I shall take notice of the palate (marked A. tab. XI.), that being a kind of basis or support to the other bones, to which they are all more or less connected. The palate is a thick and firm bone united above to the bones of the *cranium* and nose, and ending below in a flat oval surface, on which are incrustated about twelve or thirteen strong, blunt, and rather flat teeth of the *molar* or grinder kind. The external edges of the teeth are the most prominent; by which means a hollow is formed in the middle of the palate.

The upper jaw is composed of three bones, two of which (BB) are placed laterally, forming the sides of the upper jaw, and the third (C) anteriorly, making the fore-part of the jaw. The third bone may be divided through its middle into two portions; but since it has the appearance of one bone only, the connection being very firm, I shall describe it agreeably to that appearance, to prevent needless divisions.

The side bones of the upper jaw have nearly the shape of an italic *f*. At their posterior ends may be observed a smooth

articular surface, for their connection with a similar surface on the posterior extremities of the lower jaw ; and on their anterior ends there are two rows of teeth. The external row consists of three or four sharp or conical teeth ; and the internal row of four or five blunt and rather flat ones. These bones are connected to the palate and bones of the nose by loose but strong ligaments.

The third bone of the upper jaw, which may be called the anterior or nasal portion, is of a triangular form, connected above to the bones of the nose, and ending below in a flat surface, thick-set with sharp conical teeth. The external teeth, about four in number, are large and strong, and bend a little inwards ; but the internal ones are small, and nearly straight, of which we may reckon about ten.

This bone is connected above (as I have before observed) to the bones of the nose ; between which a complete joint is formed, of that kind called by anatomists *ginglymus*, that is, where the projecting parts of one bone are received by corresponding cavities in the other. Like other articulations, it is furnished with a capsular ligament, and no doubt an apparatus for the secretion of *synovia*. Although a joint exists between this bone, and those of the nose, yet no muscles are provided for its motion, which depends entirely upon the resistance made by those hard bodies which the animal takes into its mouth.

The lower jaw (D) consists of two bones, united at their fore-parts by a strong ligament, which allows of some motion. On their anterior extremities are placed six large and as many small sharp and conical teeth ; the large teeth are placed externally, and their points are bent a little inwards ; while the small ones, which stand within them, are nearly straight. Behind these are two or three rows of grinder teeth. The

external teeth stand nearly upright; but the internal ones are placed obliquely, inclining towards each other.

The teeth are formed of a hard bony matter, not covered with enamel as in some animals; nor is there an equal distribution of enamel and bone as in some others. They are not fixed in sockets, but are fastened to the jaws in the same manner as the *epiphyses* are united to the bodies of the bones in young animals.

From the foregoing description it will appear, that the anterior sharp teeth of the Sea-wolf are admirably calculated for seizing its prey, while the posterior grinding teeth serve to break down the hard shells of lobsters, crabs, muscles, scollops, &c. which this animal is known to feed upon. The external teeth on the sides of the upper and lower jaw being higher than those placed within them, a hollow is formed above and below, in which the convex shells of crustaceous animals, &c. are confined during their compression between the jaws, which is effected by the action of strong muscles placed on the sides of the head. The jaws being made up of a number of pieces, and connected by loose ligaments, a freedom of motion is allowed and the collision or shock arising from the comminution of hard bodies is so much the less by being divided among a number of bones.

MERRET informs us *, the *lapis bufonites* are the flat grinder teeth of this fish petrified. But certainly these fossils are not the production of the Sea-wolf alone, since they may originate from all those fishes which have flat teeth in their palate or jaws; a structure which the French naturalists distinguish by the appellation of *palais pavé*.

* Pinax Rerum Naturalium Britannicarum.

OF THE CHÆTODON NIGRICANS.

The individual which furnished the following account was brought from the West Indies, and measured about five inches in length*. Its teeth (the only parts I mean to describe) were so small as to require the assistance of a microscope to discover their real shape. There were fourteen teeth in each jaw, seven of which from the upper one are represented tab. XII. They consist of a cylindrical body fixed in the jaw, above which they spread out into a broad and rather flat surface, on the edges of which are twelve or thirteen *denticuli*, making an uncommon appearance, and totally different from the teeth of any other animal. Another singularity is their being transparent, unless viewed with a deep magnifier, when a few opaque lines may be perceived, which point out the cellular part of the tooth through which the blood vessels ramify, which are destined for its growth and nourishment. They are not all of the same length. Those in the anterior parts of the jaws are the longest, from whence they gradually diminish in length as they approach the angles of the mouth.

From the foregoing description of the teeth of the *Chætodon nigricans*, this fish seems to be misplaced in the *Systema Naturæ* of LINNÆUS; since one generic distinction of the *Chætodontes* is to have numerous, slender, and flexible teeth; whereas the teeth of the *Chætodon nigricans* are few in number, placed in one row, and of a crystalline hardness.

* This fish is well represented in DU HAMEL *Traité général des Pêches*, tom. III. seconde partie, section IV. planche xii. under the name of *Chirurgien ou Porte Lancette*.

OF THE TEETH OF CARTILAGINOUS FISHES.

When STENO examined the teeth of the shark, he was surprised to find a great number of them placed on the inside of each jaw, lying close to the bone, and many of them buried in a loose spongy flesh; concluding that these internal teeth could be of little or no use to the animal. Mr. HERISSANT * afterwards shewed the use of these internal or posterior teeth, by proving, that as the anterior teeth of each row are broken off, drop out, or wear away, the posterior ones come forward to supply their places †.

But though it be certain that the anterior teeth, when lost, are replaced by the posterior ones, neither of the above naturalists, or any other that I know of, have attempted to ascertain how often this circumstance happens. Whether the renovation be perpetual during life; or whether that operation be suspended after a limited number of teeth have been supplied.

From a singular circumstance, which I met with some time ago, I am inclined to think the former is the fact; or, that in cartilaginous fishes, such as sharks, rays, &c. there is a perpetual renovation of the teeth.

Being engaged in dissecting the jaws of a very large shark, I was surprised to find a portion of that sharp, bearded bone found in the tail of the fire-flare, or sting-ray ‡, driven quite

* BOMARE Dictionnaire d'Histoire Naturelle, article Requien.

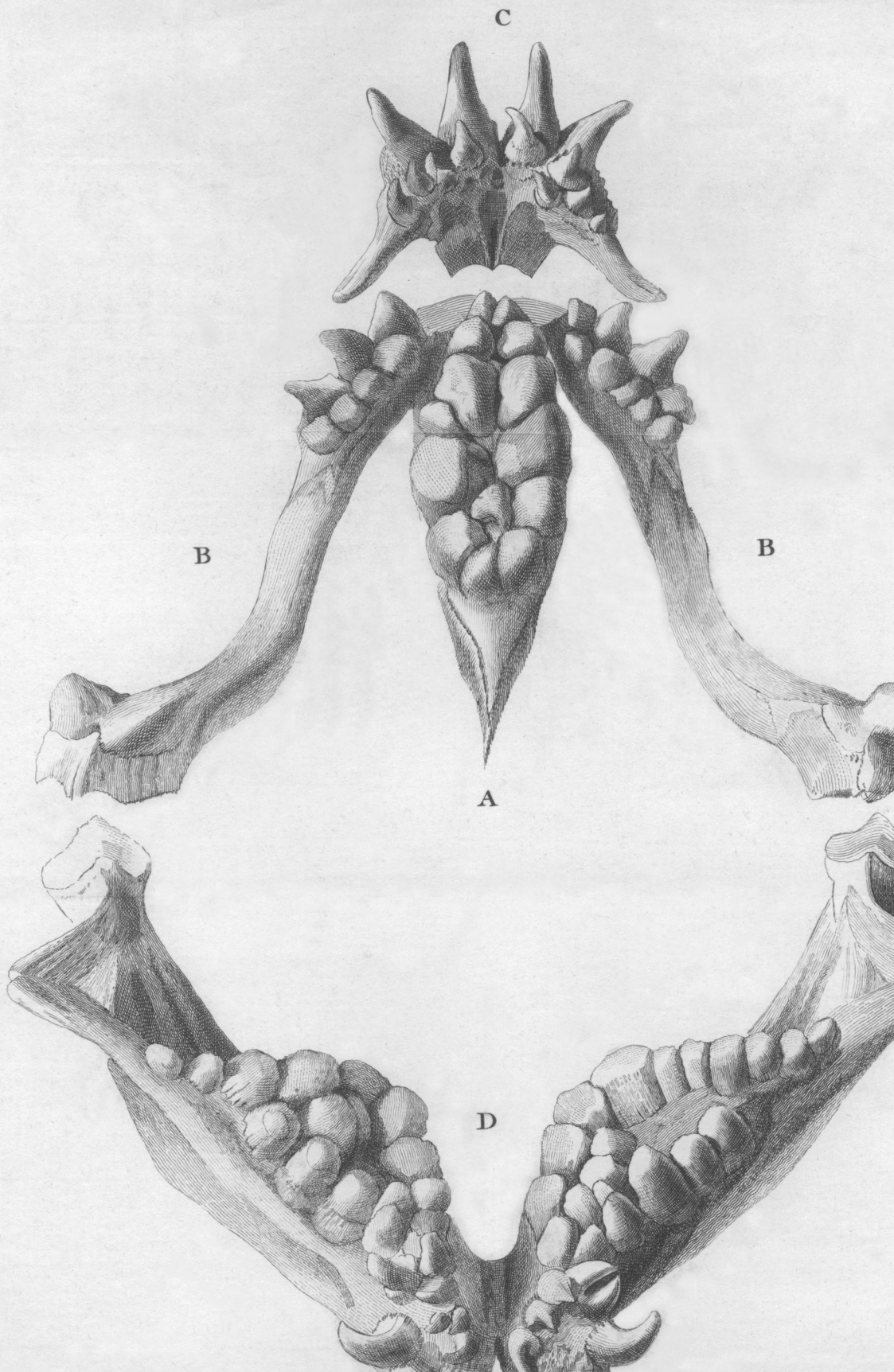
† It may not be improper on this occasion to point out a mistake which some naturalists have fallen into, in allowing a set of muscles for raising the numerous teeth placed in the jaws of sharks. I have frequently dissected the jaws of those animals, and am certain no such muscles exist, nor are they indeed at all necessary.

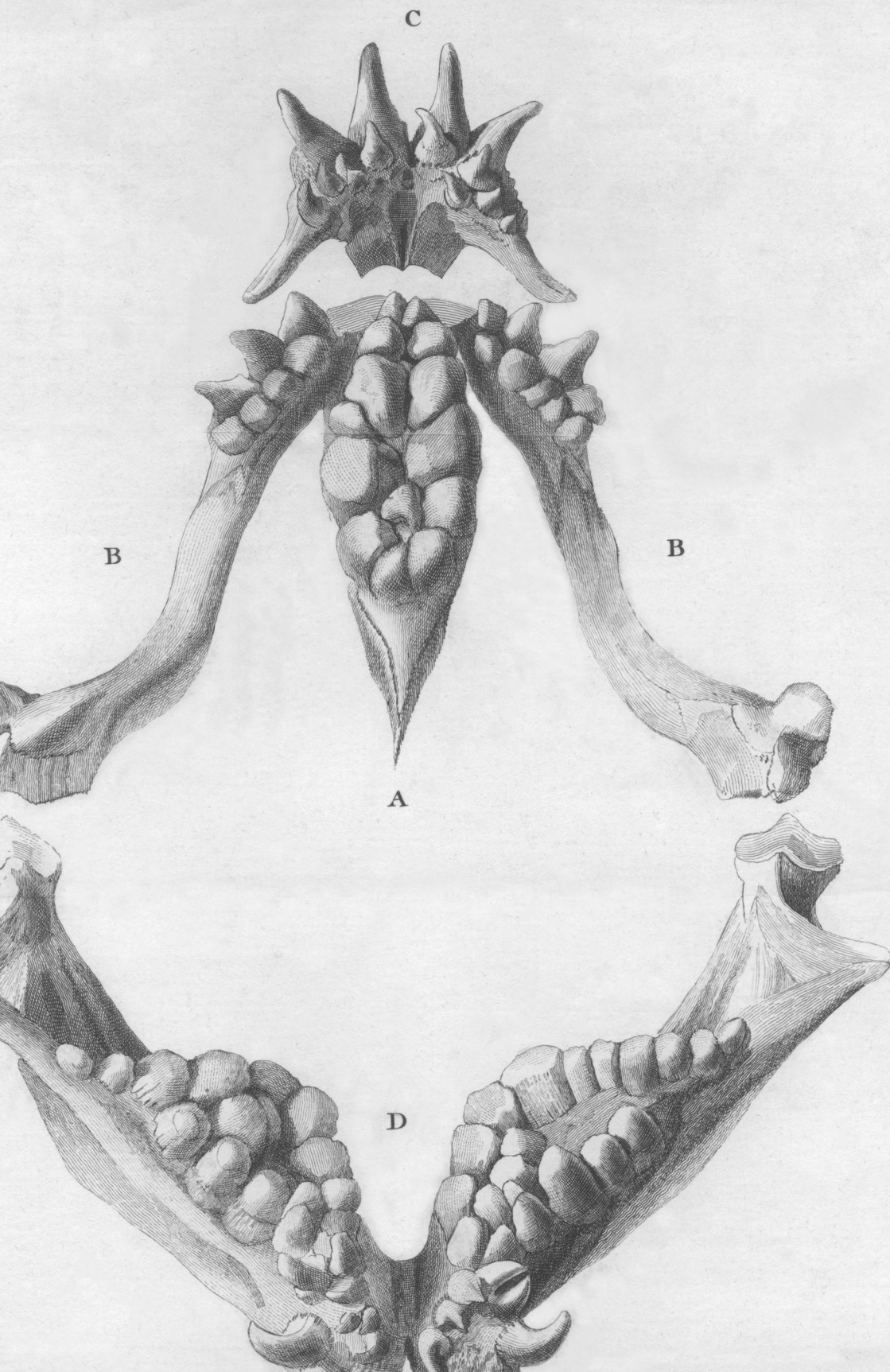
‡ *Raja Pasjinaca* LINNÆI. The French naturalists, on account of the bone in the tail, call this fish *Raie baïonnette*.

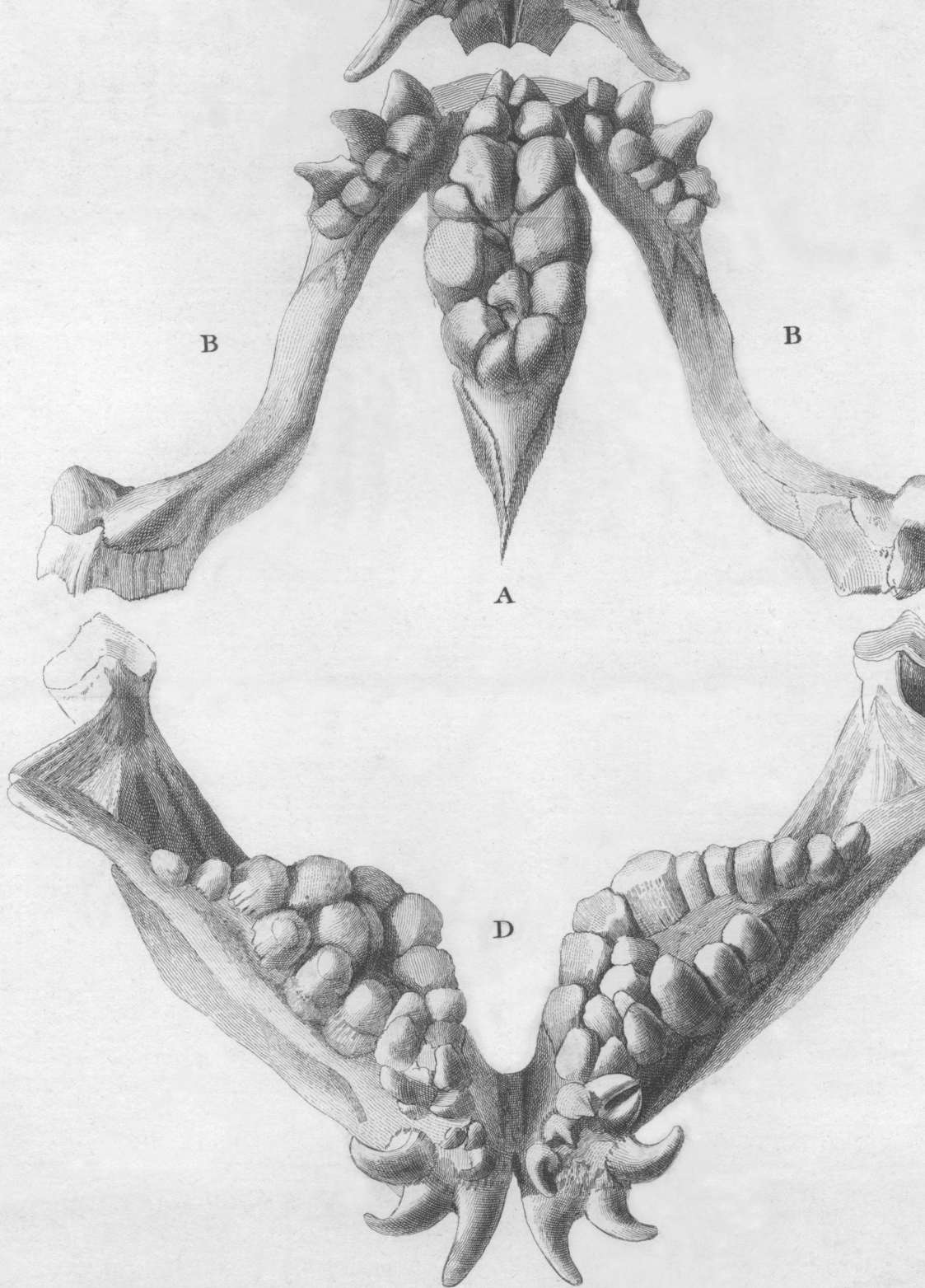
through the lower jaw among the posterior teeth, and fixed almost immoveably. How this happened must be obvious to every one. (See the figure, tab. XIII.)

Before I proceed, it will be necessary to observe, first, that the posterior teeth of cartilaginous fishes are always found in a soft, membranous state, and but imperfectly formed; notwithstanding this, they have the whiteness of teeth from a small quantity of calcareous earth already deposited within their substance. Their hardness and perfect form is acquired as they advance towards the anterior parts of the jaws. Secondly, that of the three angles in each tooth of the shark, one is placed towards the right, another towards the left, and the other, which is in the middle, and the most acute angle, is directed inwardly towards the tongue or *fauces*. They are placed then in such a manner as that the angles of the teeth on the left-side in one row, approach the angles of the teeth on the right-side in the next row. Those teeth which stand on a line from without inwards, I call a row; not those which are placed nearly in a parallel line from one side of the mouth to the other.

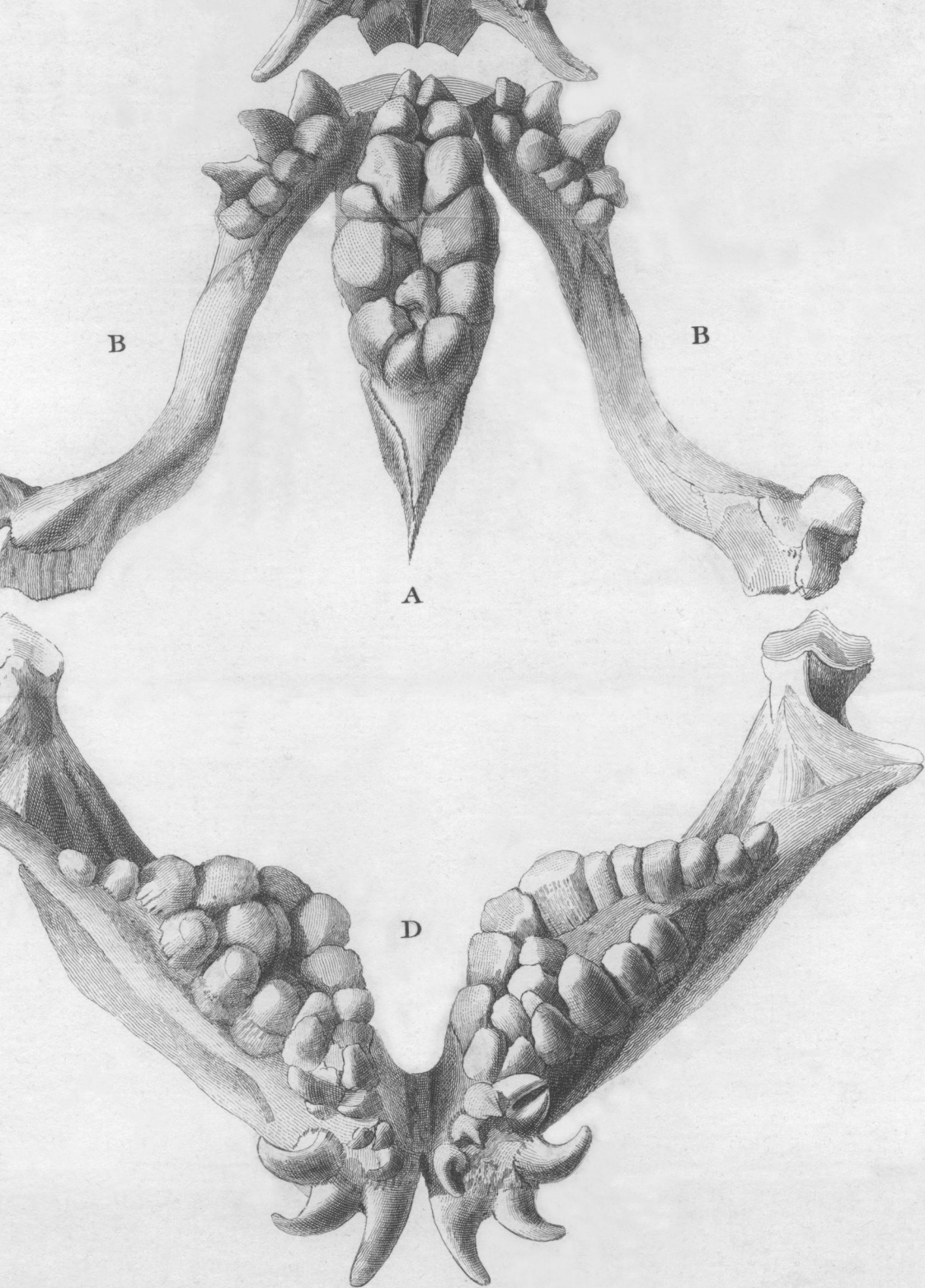
The sharp bone of the sting-ray was fixed in the lower jaw between two rows of teeth, and at their posterior part, where the first rudiments of the future teeth are formed, and it will be clear to every one, particularly those who are conversant in such matters, that this could not have happened without producing a great deal of pain, swelling, and disorder in the part where it was fixed. It is unnecessary to enumerate the different kinds of mischief this might occasion. Let it suffice to observe, that on account of the space taken up by this extraneous body, the teeth on each side of it, for want of room, could never after be perfectly formed. The teeth on the left-side
wanting



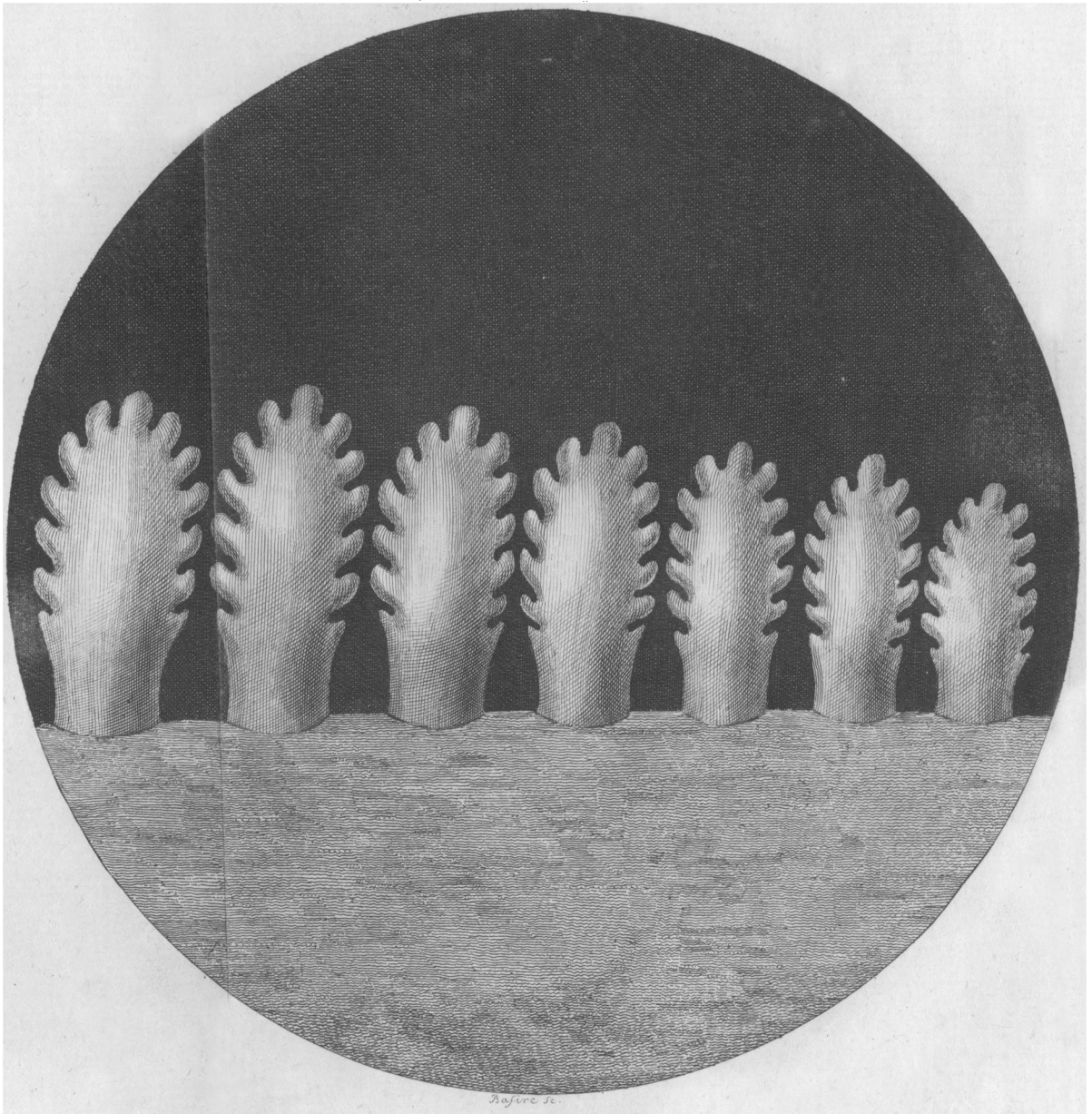




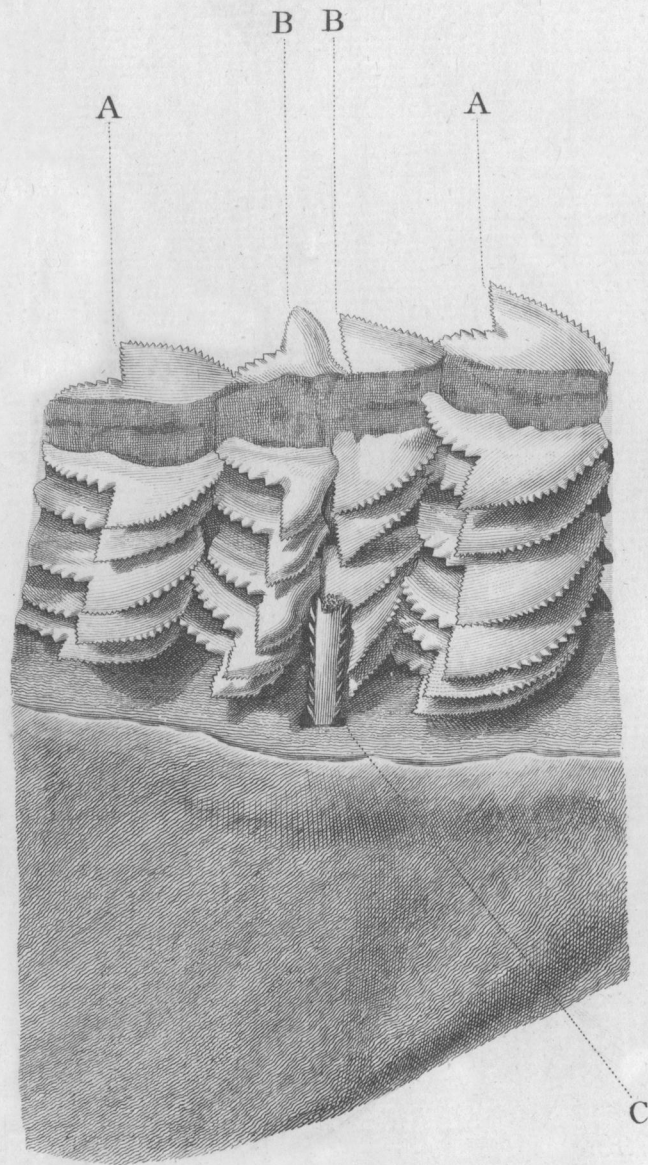
ANARHICHAS *Lupus* LINN.



ANARHICHAS Lupus *LINN.*



CHÆTODON nigricans *LINN.*



wanting their angles to the right, and the teeth on the right-side being destitute of their angles to the left.

As it is certain, that the anterior teeth were formerly posterior ones, and as the teeth in each row were all deficient in one angle, it follows, that they must have been formed posterior to the insertion of this extraneous body. Again, if we allow that before the accident the animal was in possession of perfect teeth, it follows also, that they were consumed and replaced by imperfect ones.

There were six teeth in each row, and fifty-two rows, making together about 312 teeth. Now allowing the consumption to have been equal in all parts of the jaws, it follows, that the animal had already consumed 312 teeth, and was in possession of a like number for future consumption.

The teeth of sharks, rays, &c. may be divided into active and passive. The active teeth are the anterior ones of each row, standing with their points upwards. The passive teeth are the remaining ones, lying one upon another, like the tiles upon a house (imbricated), with their points downwards. It appears from the foregoing account, that the anterior or active teeth had been replaced six times; and that they might have been renewed six times more, making in all twelve times. From which, I think, we may reasonably conclude, that this does not happen any precise number of times; but that the renovation is perpetual during the life of the animal.

The longevity of fishes is a fact pretty well established. In addition to this part of natural knowledge, I have endeavoured to prove, that a part of the inhabitants of the great deep retain, in the article of teeth, a perpetual juvenility, being apparently utter strangers to edentulous old age.

EXPLANATION OF THE PLATES.

Tab. XI. The jaws of the Wolf-fish.

A. The palate.

BB. The side bones of the upper jaw.

C. The anterior or nasal portion of the same.

D. The lower jaw.

Tab. XII. The teeth of the *Chaetodon nigricans* magnified.

Tab. XIII. Part of the lower jaw of a large shark.

AA. Two rows of perfect teeth.

BB. Two rows of imperfect ones.

C. The bone of the sting-ray.

